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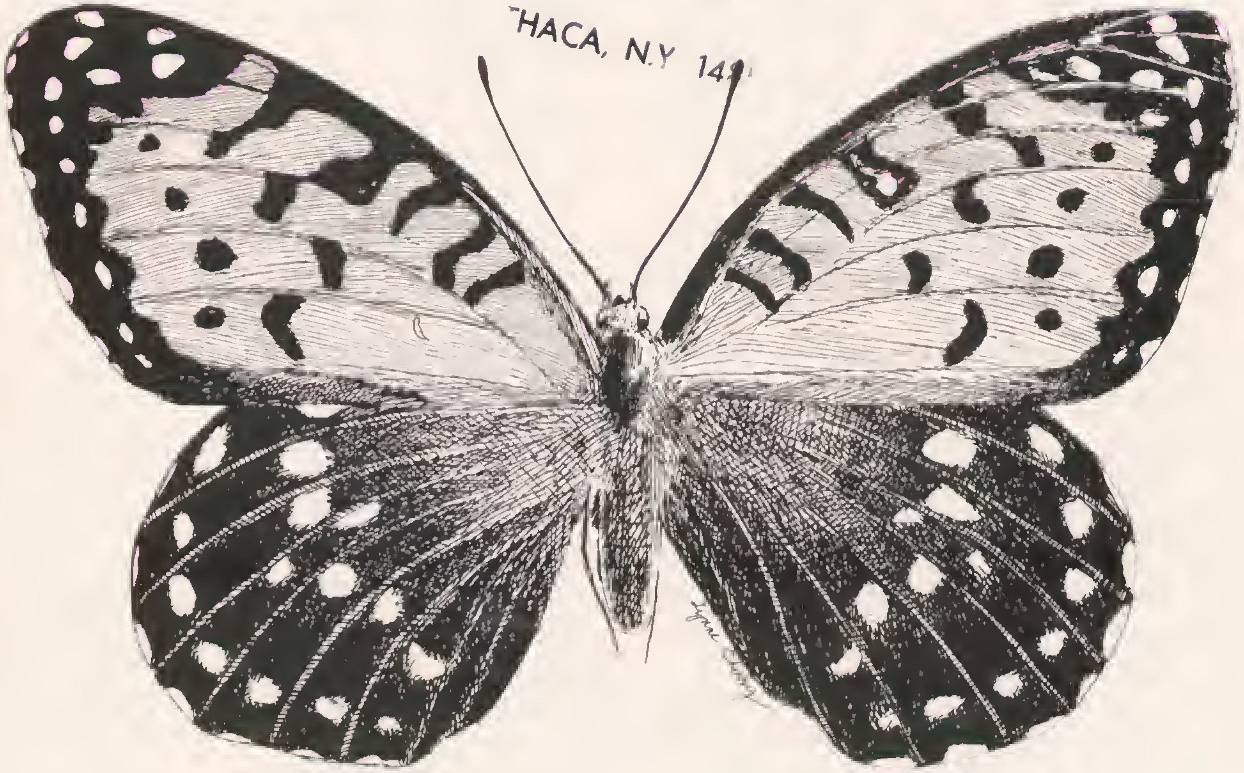

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Articles

Competition as a Controlling Factor of *Euphilotes battoides allyni* Larval Abundance (Lepidoptera: Lycaenidae)

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Abstract

The endangered El Segundo Blue butterfly, *Euphilotes battoides allyni*, is restricted to remnant coastal dune habitat in southern California. Its sole larval host, *Eriogonum parvifolium*, is shared with many other insects. The flowers of *Eriogonum parvifolium* were sampled from 17 July to 3 September 1985 and on 20 August 1986, at the El Segundo Dunes of Los Angeles County. High numbers of microlepidopterous larvae in the families Cochylidae and Gelechiidae were found in the flowers in 1985. These microlepidoptera compete directly and intensively with *E. b. allyni* for food resources and also share some parasitoids. The microlepidoptera, unlike *E. b. allyni*, are multivoltine and utilize an additional host, *Eriogonum fasciculatum* which generally blooms earlier than *E. parvifolium. Eriogonum fasciculatum* is abundant, but not native to the dune habitat. After initial dune habitat restoration efforts consisting chiefly of reduction of non-native plants, including *E. fasciculatum*, the abundance of microlepidopterous larvae on *E. parvifolium* declined while the abundance of *E. b. allyni* larvae increased.

Introduction

The El Segundo Blue, *Euphilotes battoides allyni* (Shields), is a Federally listed endangered butterfly. It is restricted to southern California dune remnants totalling less than 150 hectares of a once expansive area (181 square km) extending from Marina Del Rey to San Pedro, California (Pierce and Pool, 1938; Cooper, 1969; Powell, 1981). The larvae of this butterfly feed only on the flowers and seeds of the buckwheat *Eriogonum parvifolium* Sm. in Rees. (Shields, 1975, personal observation); adults use it as their major nectar source. Although there have been some studies on the biology of *Euphilotes* (Arnold, 1983a, 1983b; Shields, 1975, 1977), little has been published on the early stages.

Numerous insects live in the *Eriogonum parvifolium* inflorescences along with El Segundo Blue Larvae. These include lepidopterous larvae in the families Cochylidae, Gelechiidae, Geometridae, Riodinidae, and even other Lycaenidae. The microlepidopterous Gelechiidae and Cochylidae have the greatest effect on the El Segundo Blue. Immatures belonging to the orders Coleoptera, Diptera, Hemiptera, Homoptera, and Hymenoptera are also found in the blossoms (some of these insects are probably also specific for *Eriogonum*). In any case, the *Eriogonum* inflorescences are attractive to many species of insects and form a complex, largely self-contained community.

Many of the insects found with the El Segundo Blue larvae probably affect the larvae to varying degrees through competition, predation, and parasitism. In some cases, as with ants, the interactions may be mutually beneficial. Because the *E. parvifolium* inflorescences represent a limited nutritive resource, competition for them can be extreme, particularly between lepidopterous larvae. Perhaps this is why there is cannibalism within and predation among species, in the inflorescences of *E. parvifolium.* For example, when the microlepidopterous larvae have been mistakenly reared with *E. b. allyni* larvae, the *E. b. allyni* larvae are often found dead and shriveled, at the bottom of the container. By sampling insects in the *E. parvifolium* flowers at the El Segundo Dunes near the Los Angeles international airport, the effects of these other insects on *E. b. allyni* larvae with respect to competition, predation, and parasitism can be estimated. The densities of *E. b. allyni* larvae in the flowers should also help predict future populations. Because *Euphilotes* pupae have been shown to be able to delay emergence (Pratt and Ballmer, 1987), the pupae formed from these larvae will not necessarily be a part of the next year's adult population, but form a part of a seed bank, so to speak, for future populations.

The many insects that eat *Eriogonum* inflorescences can be classified into two basic groups, according to differences in their utilization of this resource. Some insects which are univoltine, such as *E. b. allyni*, specialize on the relatively short blooming season of a single *Eriogonum* species. Others are multivoltine and opportunistic feeders, utilizing multiple hosts, as with the microlepidoptera. Despite the fact that a single species of *Eriogonum* may be favorable to the specialist, it does not always preclude its use by an opportunist. For instance, although *E. parvifolium* blooms mainly in July and August, there are always some plants that bloom sporadically throughout the remainder of the year, maintaining low numbers of the multivoltine microlepidoptera or opportunists. Therefore, the increase in the length of the *Eriogonum* bloom at the El Segundo dunes, through the introduction of the earlier blooming *E. fasciculatum*, should cause a perturbation in the *E. parvifolium* system by increasing the numbers of opportunists prior to the plants' summer bloom.

Three results of the introduction and subsequent reduction of *E. fasciculatum* can be expected. One is that *E. parvifolium* plants closest in proximity to *E. fasciculatum* should have the greatest increase in microlepidoptera numbers. Secondly, the onset of the increase in microlepidoptera on *E. parvifolium* should correspond to the senescence of the *E. fasciculatum*. Thirdly, reduction of *E. fasciculatum* plants should cause a decrease in the microlepidoptera and an increase in *E. b. allyni*.

Materials and Methods

The three introduced *Eriogonum* species are distributed at the dunes as shown in Fig. 6. *Eriogonum parvifolium* is found along the slope facing Pershing Drive scattered in among the other *Eriogonum* species, and in the foredunes just west of the V.O.R. site, in addition to the main sites 1, 2, and 3.

Eriogonum parvifolium inflorescences were collected every 2-6 days from 17 July to 3 September 1985 (Fig. 1) and again on 20 August 1986 from 3 different sites on the dunes. Site 1 (5 sq m) had approximately 1000 inflorescences, site 2 (10 sq m) had approximately 10000 inflorescences, whereas site 3 (20 sq m) had approximately 8000 inflorescences. These sites were located different distances from the main *E. fasciculatum* stand (Fig. 6). At least 2 flower branches were taken from north, south, east, west and central exposures of plants at each site. They were examined under a binocular dissecting microscope and the insect numbers, particularly larvae, were recorded. After examination the flowers were placed in a 25 ml graduated cylinder with 10 ml water to obtain their volume displacement.

During the spring of 1986, *Eriogonum fasciculatum* plants found between sites 1 and 2 were carefully pruned, to avoid disturbing other native and endemic plants found at the El Segundo Dunes. This involved cutting the plants back and digging up as much of the roots as possible. The *E. fasciculatum* were cut back because the microlepidoptera were believed to have increased greatly on them prior to the *E. parvifolium* bloom in 1985. Approximately one third of the plants showed some regrowth by the summer of 1986.

The last instar larvae of the three lycaenids *Strymon melinus* Hubner, *Icaricia acmon*, (Westwood & Hewitson) and *Euphilotes battoides allyni* were identified using a new larval key by Ballmer and Pratt (unpubl. ms.). Earlier instars are easily separated: *S. melinus* has a pale large head capsule, while those of *E. b. allyni* and *I. acmon* are smaller and dark; *I. acmon* has more dorsal prominent setae than *E. b. allyni*. Larvae of *Apodemia mormo virgulti* (Behr) (Riodinidae) normally fed nocturnally and were only observed feeding on the inflorescences once (on a cool cloudy day). The larvae of the microlepidopterous families Gelechiidae and Cochylidae were not separated from each other. The gelechiid is a species belonging to the *Aroga parapluttela/unifasciella* complex; the cochylid was not identified. Additional species (including a geometrid) were not abundant enough to be included in the data.

Eggs of *E. b. allyni* were difficult to find on the Buckwheat flowers and only a few of them were parasitized by *Trichogramma* sp. nr. *minutum* Riley (*Strymon melinus* tends to place its eggs on the involucres, making them easier to locate). The ratio of blackened (parasitized) eggs to the total number of eggs observed was considered to be the percent egg parasitism of that species. Two species of Hymenoptera were observed parasitizing lepidopterous larvae in the *Eriogonum* flowers. These parasites often pupated with the bodies of the dead larval hosts in the *Eriogonum parvifolium* flowers. The parasites were identified by differences in external characteristics of the cocoons.

Results

As can be seen in Figure 6, site 1 is closest in proximity to the largest density of *E. fasciculatum*, with sites 2 and particularly 3 being distant to *E. fasciculatum*. It is not surprising, therefore, that site 1 had the highest number of microlepidoptera or opportunists in 1985 (Fig. 2). Although site 3 was furthest from dense stands of *E. fasciculatum*, it had a similar maximum to site 2, yet had more variable numbers of microlepidoptera. These numbers of 350 to 700 larvae per 50cc of flowers (1cc = 1 flower cluster) are probably far above the carrying capacity of the *Eriogonum* making competition for a limited resource potentially extreme.

At all three sites there was an approximate doubling in microlepidopterous larvae on the *E. parvifolium* around mid August 1985 (Fig. 2). Considering that generation times are about a month for the microlepidoptera, this doubling on the *E. parvifolium* corresponds to the major period of senescence of *E. fasciculatum* around mid July.

Eriogonum fasciculatum was pruned heavily between site 1 and site 2 in the spring of 1986, causing a reduced and delayed bloom in those plants that survived. Therefore, the initial population of microlepidoptera was reduced in numbers and the delayed bloom of the *E. fasciculatum* provided subsequent generations with less opportunity to switch to the *E. parvifolium.* This probably is the reason that the follow-up sample sizes of microlepidoptera taken on 20 August 1986 were 1/5 those for the corresponding times in 1985 at all three sites. This reduced feeding and competition probably was responsible for the noticeable increase in *E. b. allyni* larvae from zero on 21 August 1985 to 8 and 12 on 20 August 1986, at sites 1 and 2 respectively (Fig. 1). Site 3 had approximately the same numbers both years; it may have been least affected by the pruning, since the site was most distant from *E. fasciculatum* stands.

The microlepidoptera were heavily parasitized by the braconid *Apanteles thurberiae* (Mues.) and an ichneumonid, a *Diadegma* F. sp. The braconid also parasitizes *Euphilotes* larvae, so an increase in the microlepidoptera probably causes a relative increase in the braconids which would have a negative effect on survival of *E. b. allyni* larvae.

Unlike the microlepidoptera, *Strymon melinus* larval density did not increase greatly in numbers (Fig. 5) around mid August. There also did not appear to be any difference in *S. melinus* larval numbers between 1985 and 1986, which is surprising since there may have been fewer eggs in 1986 (Fig. 4). *S. melinus* larvae are less stationary than the microlepidoptera, making sampling of the larvae less accurate than that of the eggs. A greater number of *S. melinus* eggs at the El Segundo Dunes would probably cause a relative increase in the *Trichogramma* sp. nr *minutum* that parasitize both *S. melinus* and *E. b. allyni* eggs. The *Trichogramma* were infrequent in the microlepidopterous eggs.

Discussion

The following 4 facts demonstrate that *E. fasciculatum* was recently introduced into the El Segundo Dunes. One, aerial photographs from 1966, which antedate the hydromulching done along Pershing Drive (Fig. 6), show no bushes in the area where *E. fasciculatum* is now common, only grassland. Two, other non-native *Eriogonum* species, such as *E. giganteum* and *E. cinereum* have also been introduced through this general seed mulching. Three, *Apodemia mormo virgulti*, which is most often specifically associated with *E. fasciculatum* even in the presence of *E. parvifolium* (as seen at nearby Crystal Cove, Orange, Co.), is not so associated at the dunes (the metalmark is generally more abundant around *E. parvifolium*). Four, *E. battoides bernardino*, which is typically found with native stands of *E. fasciculatum*, is absent.

The flowers and seeds of *Eriogonum parvifolium* form the matrix of a complex self-contained community. This plant structure is probably the most important part of the plant to herbivores, since it provides the most concentrated nutritive resource and offers good protection from predators. These herbivores (particularly larvae) spend most of the daylight hours in the flower clusters, making monitoring methods fairly accurate representations of field numbers.

The proximity of site 1 to a dense *E. fasciculatum* stand probably was the reason for it having the highest abundance of microlepidoptera. In addition, the period of the *E. fasciculatum* senescense plus the developmental time of the microlepidoptera corresponded well to their large increase on the *E. parvifolium* flowers. The abundant microlepidoptera – 350-700 per 50cc of *E. parvifolium* flowers – probably not only removed most of the seeds or food for the *E. battoides* larvae, but probably also fed on the *E. battoides* larvae (as is witnessed under laboratory conditions). The reduction of the *E. fasciculatum* therefore not only caused a decrease in the microlepidoptera, but an increase in the *E. battoides.* It would seem, therefore, that the microlepidoptera at the El Segundo Dunes increased through the introduction of *E. fasciculatum*, which in turn probably caused the decrease in *E. battoides allyni.* The removal of the *E. fasciculatum* should help return the El Segundo blue's habitat to its original state.

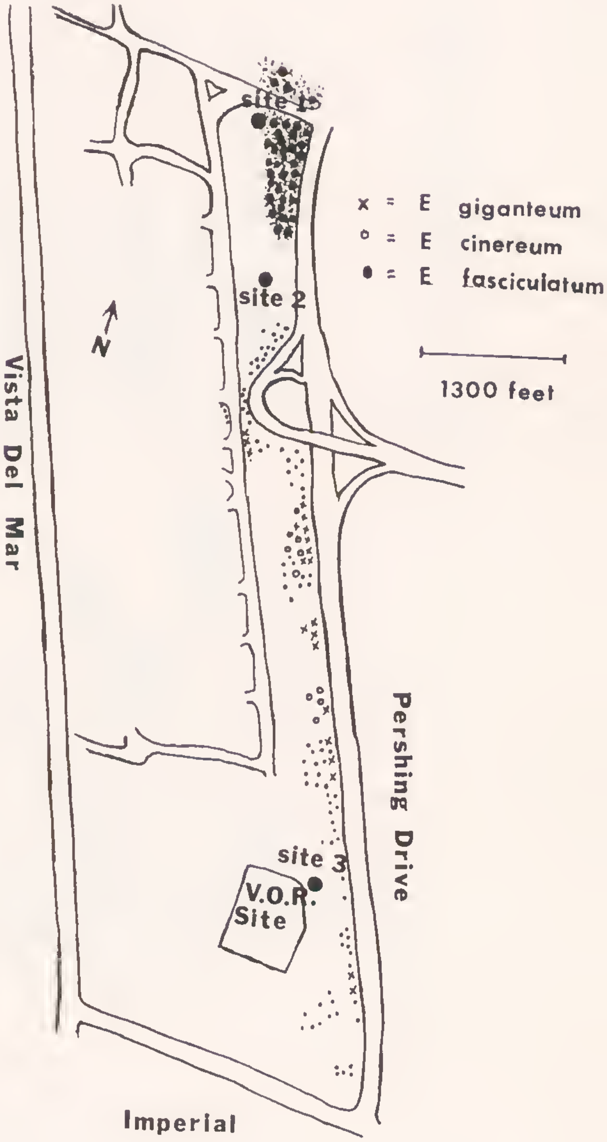

Figure 6. Map showing the three study sites, and the *Eriogonum fasciculatum* plants found on the El Segundo Dunes. The *E. fasciculatum* between Sites 1 and 2 was pruned extensively.

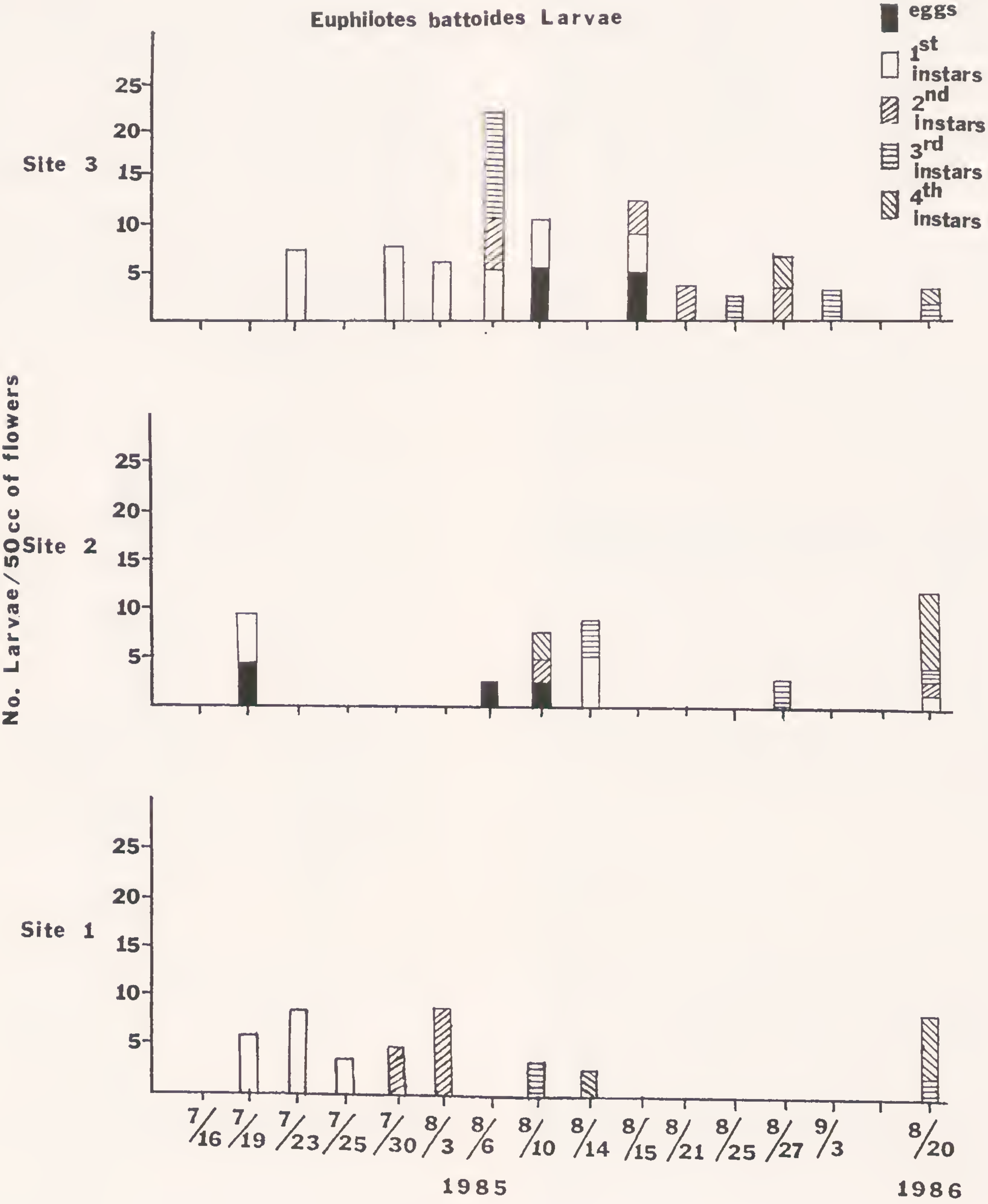

Figure 1. Number of *Euphilotes battoides allyni* eggs and larvae per 50cc of *Eriogonum parvifolium* flowers on 16 July 1985 to 3 September 1985, and 20 August 1986 at the three study sites.

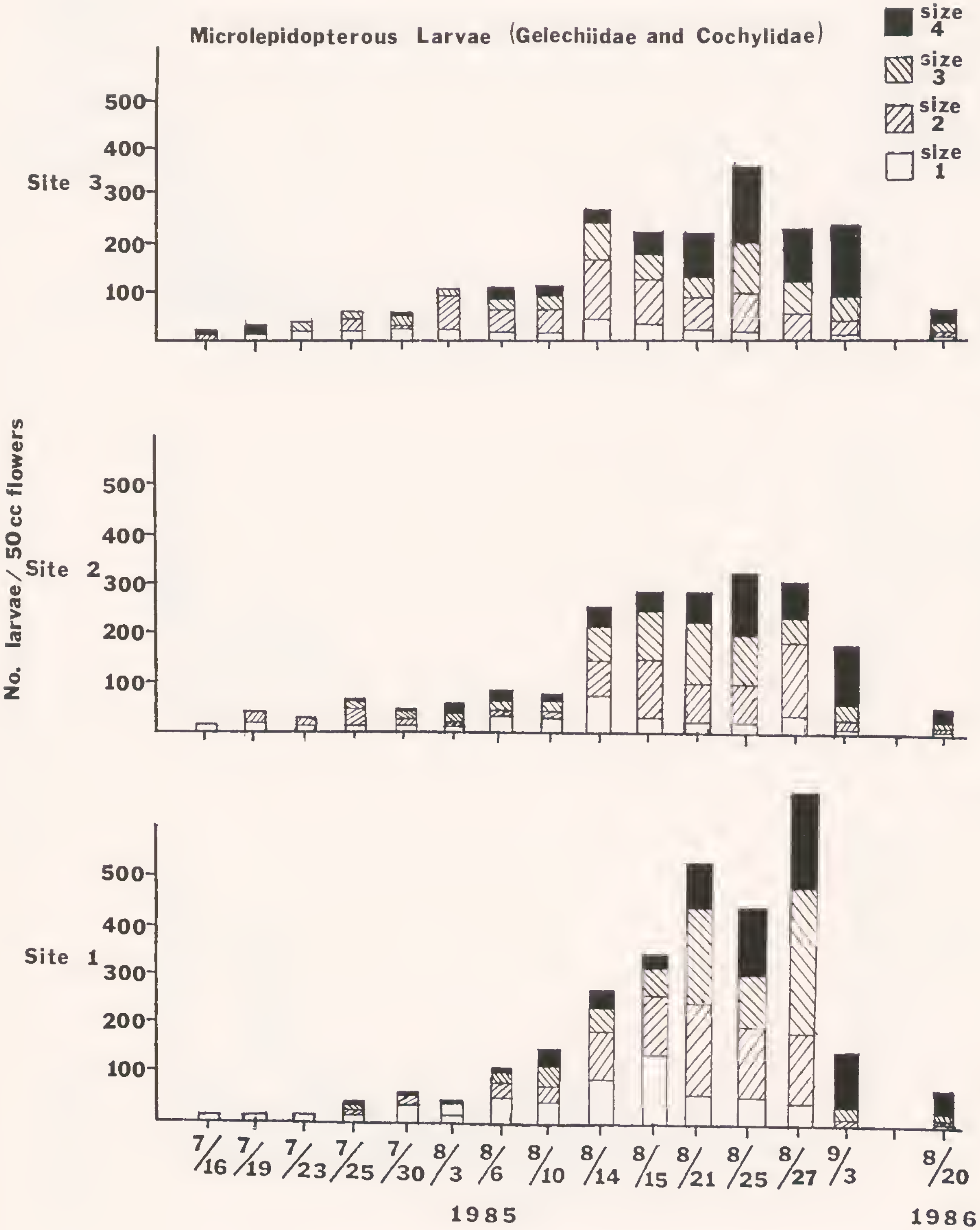

Figure 2. Number of microlepidopterous larvae per 50cc of *Eriogonum parvifolium* flowers on 16 July 1985 to 3 September 1985, and 20 August 1986 at the three study sites. The four different sizes are approximations of four different instars.

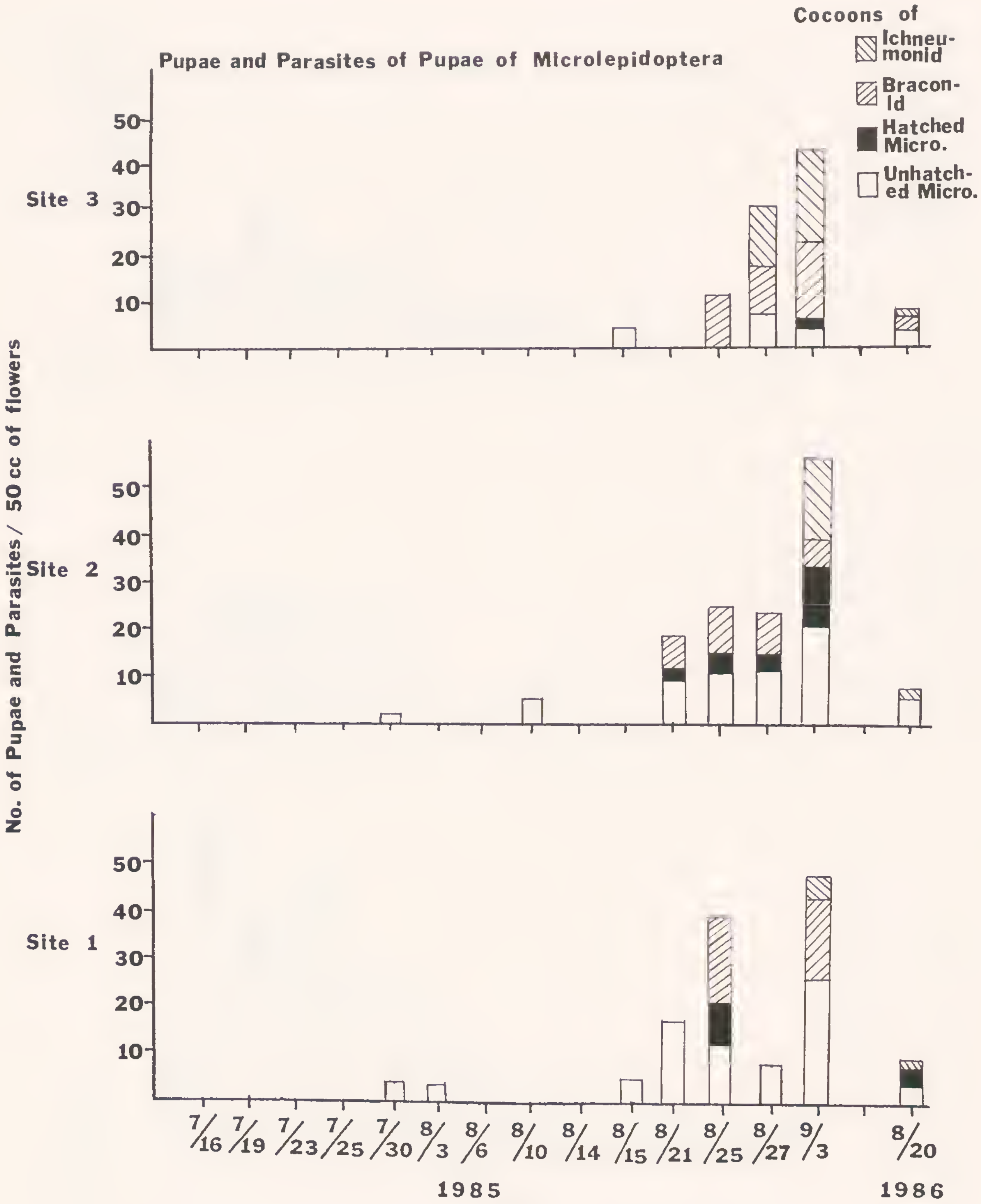

Figure 3. The microlepidoptera pupae and parasite pupae found in the microlepidoptera cocoons per 50cc of *Eriogonum parvifolium* flowers on 16 July 1985 to 3 September 1985, and 20 August 1986 at the three study sites.

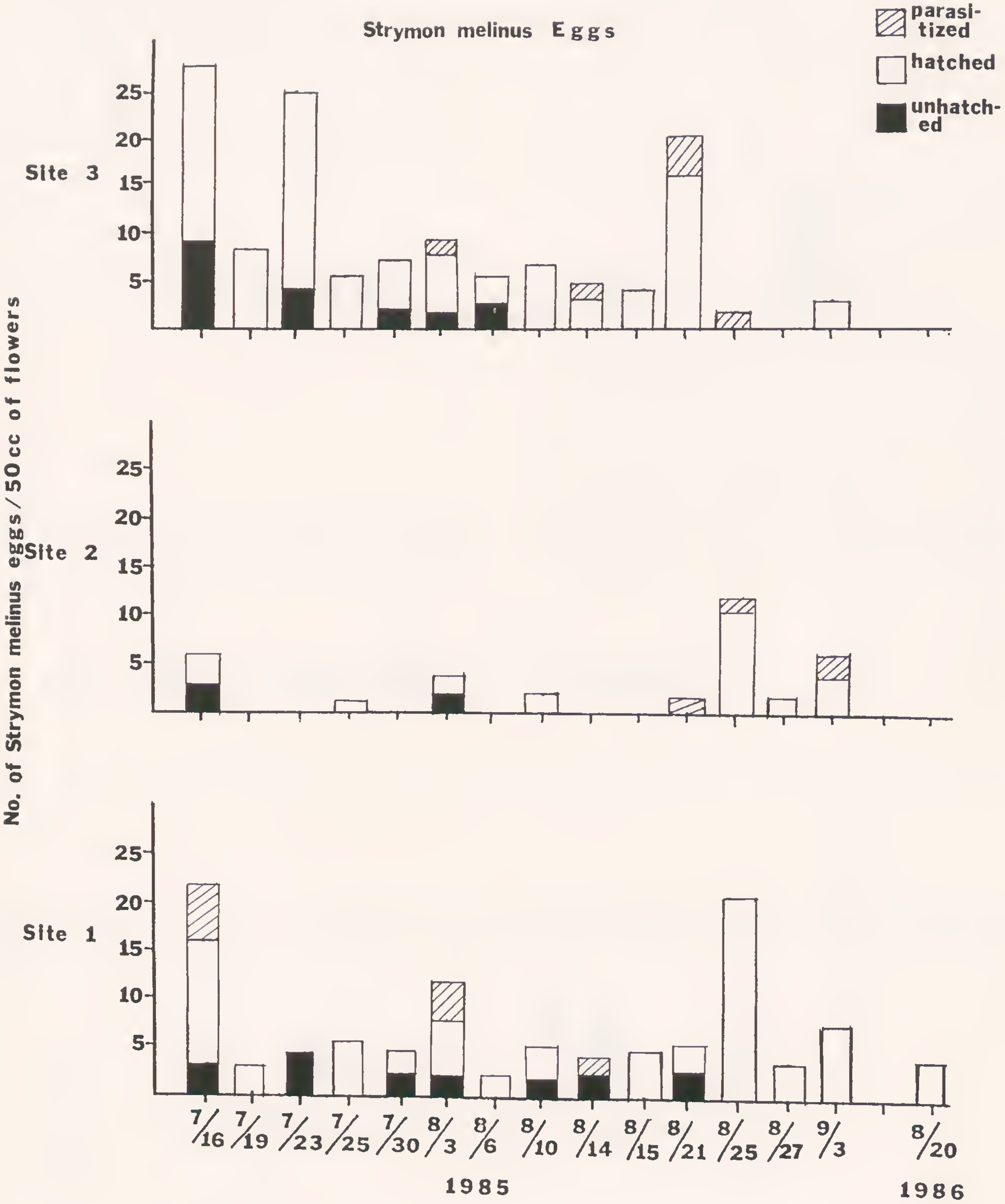

Figure 4. *Strymon melinus* parasitized, hatched, and unhatched eggs found in 50cc of *Eriogonum parvifolium* flowers on 16 July 1985 to 3 September 1985, and 20 August 1986 at the three study sites.

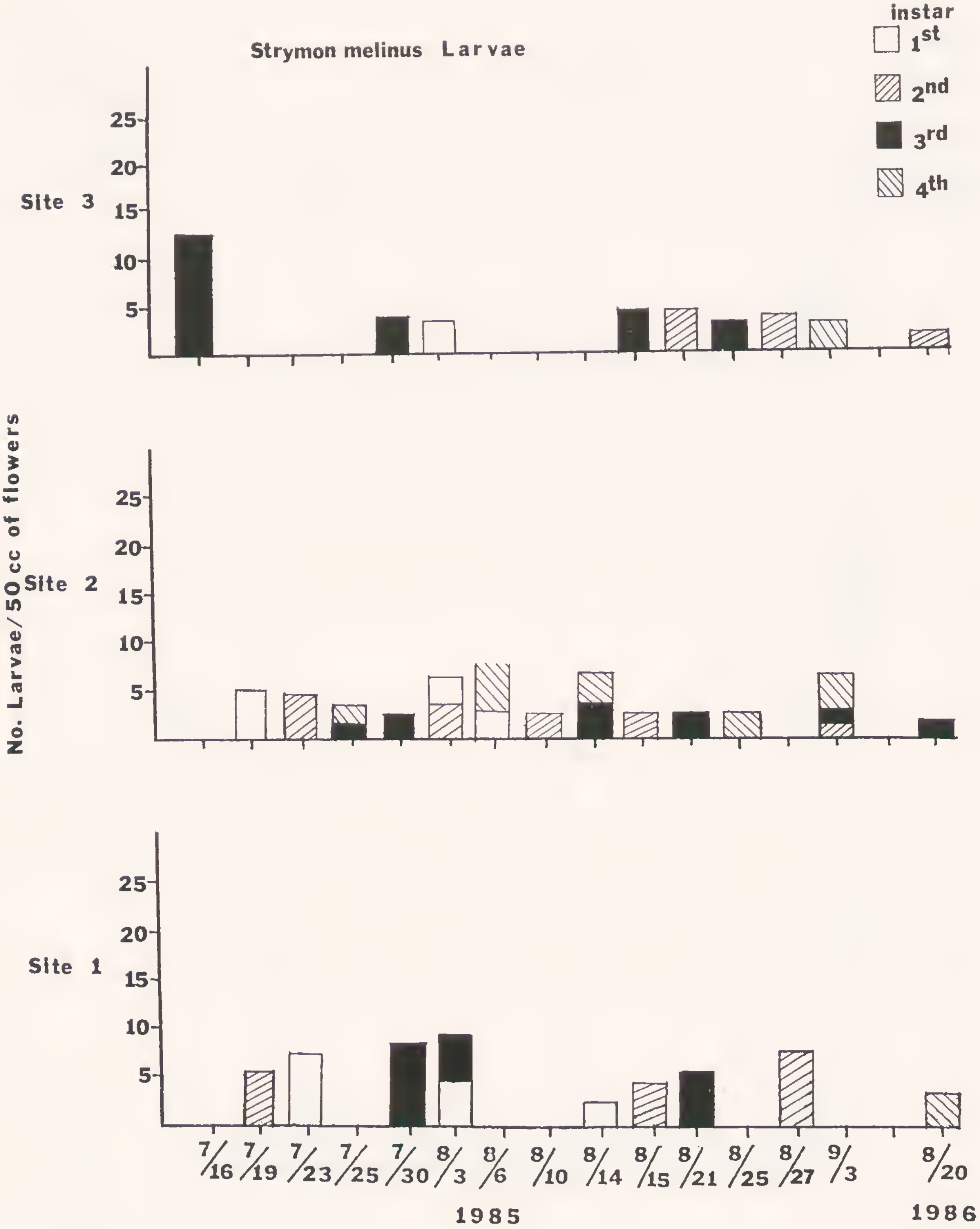

Figure 5. *Strymon melinus* larvae found in 50cc of *Eriogonum parvifolium* flowers on 16 July 1985 to 3 September 1985, and 20 August 1986 at the three study sites.

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Observations on the Ecology, Nectar Sources, and Occurence of *Vanessa cardui* and *Vanessa virginiensis* in the Memorial University Botanical Garden (Avalon Peninsula, Newfoundland, Canada)

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Abstract

Field observations on painted lady butterflies in Newfoundland, Canada, for the past twelve years are presented, with discussion of adult flight behavior, nectaring activity, and larval habits.

During twelve flight seasons I monitored the occurrence and activities of the Painted Lady (*Vanessa cardui* L.) and the American Painted Lady (*V. virginiensis* Drury) butterflies in the Memorial University Botanical Garden, situated at St. John's (47d 34m N, 52d 43m W), on the Avalon Peninsula of Newfoundland, Canada.

Though the Painted Lady has been known from Newfoundland for well over a hundred years, it was not until 11 September 1972 that the American Painted Lady was first recorded there (Jackson, 1976). This sighting, made at the Memorial University Botanical Garden, triggered the idea for my lengthy comparison of the two species. A further specimen of *V. virginiensis* was taken 17 September 1972 at Musgravetown, Newfoundland (48d 24m N, 53d 53m W) by R. Stead, on 17 September, (R. Morris, pers. comm.). Since the original sighting I discovered a mounted but previously unidentified specimen of the American Painted Lady taken by John Phipps at St. John's during August, 1970. This specimen now constitutes the first known record of *V. virginiensis* in Newfoundland.

During the period of 1972-1983 all individual sightings of both species in the study area were recorded. Though an attempt was made not to count the same individuals twice, those individuals habitually frequenting the same site could possibly have been recorded more than once. However, since a consistency of method was maintained, a general population comparison can be made. Data collected indicate that sightings of *V. virginiensis* and those of *V. cardui* were in a ratio of 1:11 (Table 1). In 1976 and 1977 the former outnumbered the latter. If a similar ratio occurs outside the Garden's boundary, throughout the whole Province, the American Painted Lady cannot now be considered the rare butterfly in insular Newfoundland it was once believed to be.

Though most unusual, the occasional individual of either species may overwinter in Newfoundland. I recall seeing a couple of very worn specimens emerge along with the overwintering Milbert's Tortoise Shells (*Nymphalis milberti*) from a dry stone wall, some years ago. At the time I did not have the necessary equipment to catch them, so am unable to say which species they were. I have no records of either species overwintering in the study area. Pyle (1981) suggests that of the two species, *V. virginiensis* is the more tolerant of cold and the only one likely to be able to overwinter in the north. Both species migrate into Newfoundland but do not necessarily reach the study area annually. Whether or not they migrate out of, as well as into Newfoundland, is not known. Though numerous freshly emerged individuals frequenting the Garden's flowerbeds have been known to quite suddenly disappear simultaneously, no work to record migration, either way, has yet been attempted. Until extremely large numbers of these creatures are banded and worked upon as has been done with the Monarch butterfly, I cannot see this query being answered.

The earliest seasonal recorded sighting of *V. cardui* in the Garden is 30 May and the latest sighting 24 October. In a "painted lady" year, *V. cardui* is seen occasionally throughout the whole summer, whereas *V. virginiensis* has never been observed before 29 July (one sighting) or after 5 October. Clench (*in* Howe, 1975) states that it

	V. cardui	V. virginiensis
1972	9	3
1973	59	0
1974	0	0
1975	0	0
1976	2	4
1977	1	8
1978	21	1
1979	59	2
1980	0	0
1981	58	3
1982	0	0
1983	40	2
TOTAL	249	23

Table 1. Number of individual sightings of *Vanessa cardui* and *Vanessa virginiensis* in the Memorial University Botanical Garden.

is not known whether *V. virginiensis* migrates. I would suggest that there is a small, fairly regular migration of this species into insular Newfoundland from mainland Canada, possibly via the French Islands of St. Pierre et Miquelon. Of the period under discussion, *V. cardui* has been absent four years and *V. virginiensis* five years out of the twelve.

V. cardui usually, though not always, arrives in the study are early enough in the season to permit breeding. Here it has been recorded ovipositing on Canada Thistle (*Cirsium arvense*), Garden Borage (*Borago officinalis*), Viper's Bugloss (*Echium plantagineum*) and Musk Mallow (*Malva moschata*). Outside the Garden it has also been recorded ovipositing on Black Knapweed (*Centaurea nigra*) by myself, and Alkanet (*Anchusa sp* .), Perennial Lupine (*Lupinus hybrids*) and *Artemisia* sp., by other observers. I have a report of larvae being found feeding on Wild Hollyhock (*Sidalcea malvaeflora*) in a local garden but was not able to verify this at the time.

Though most authors (Goodden 1978; Pyle, 1981) suggest that thistle is the principal or preferred host plant for this species, observations would indicate that whenever the chance presents itself these insects oviposit on Viper's Bugloss in the study area far more readily than they do on thistle. Elsewhere in Newfoundland this is not necessarily so, for the Canada Thistle is a fairly common, widespread weed, whereas Viper's Bugloss is an uncommon annual bedding plant found only in a very few local gardens. This characteristic has proven most valuable to me. It has allowed me to encourage this butterfly by planting additional *Echium* while at the same time discouraging the less desirable Canada Thistle.

The eggs of the Painted Lady butterfly are typically nymphalid, and are laid singly, on the dorsal side of the leaf, slightly in from the edge. Not all eggs are laid during the same period; indeed, newly laid eggs can sometimes be discovered on plants where there are larvae in varying stages of development. Due possibly to the continuing influx of new females into the area throughout the summer, the ovipositing season of this species may extend beyond three months. Depending on the weather, caterpillars emerging later may not fully develop. During favourable climatic conditions the egg stage may last as little as five days.

The newly emerged larva eats part of the egg shell, then crawls away, and within ten hours has built a simple tent of silk and taken its first meal from the leaf epidermis. As the caterpillar grows, larger portions of the whole leaf are consumed and the protective silken tent becomes larger and more solidly built. When *Echium* or Borage is used as a host the caterpillar usually builds its tent close to, or amongst, a flower cluster. To make its tent the caterpillar simply pulls together some leaves or flowerheads and fastens them with silk. The percentage of silkwork in the tent can vary significantly. Larger caterpillars, especially when feeding from Canada Thistle (*Cirsium arvense*) are inclined to camouflage the tent with plant debris such as the thistle spikes. I have seen some large, compact ones that were almost completely covered with these spikes. Caterpillars change these protective sites as they grow, leaving the empty ones filled with their droppings.

The caterpillar's colour is changeable. When young they are usually black. Individual pairs of black spines are found on each body segment, except for three pairs which are yellow. Larger larvae can be very variable in their colouration. Tones ranging from black through green to greenish-grey, have been observed within the Garden. In the final instar, shortly before pupation, the caterpillar leaves the nest and forages more freely over the plant. Pupation may take place either on or well away from the host plant. To pupate, the larva suspends itself upside down, from a silken pad spun onto the chosen substrate. Usually it is suspended from the underside of a leaf or from a more solid fixture nearby, but occasionally the caterpillar will weave a flat net between the rolled-under edges of some large leaf (e.g., a cucumber leaf) and hang from this to pupate. The chrysalis is greyish (occasionally green), with a metallic golden sheen. There are two hump-like projections on top of the thorax, with a shallow indentation just behind them. Dimple-like depressions run in rows down the abdomen.

V. virginiensis has not been recorded breeding in the Garden; indeed, until recently it was not known to breed anywhere in Newfoundland. My limited records

Exotic		Vanessa cardui	Vanessa virginiensis
Annuals			
Candytuft	*Iberis umbellata*	x	
Cone Flower	*Rudbeckia* "My Joy", *R.* "Marmalade	x	x
Cosmos	*Cosmos bipinnatus*	x	
Floss Flower	*Ageratum houstonianum* "Blue Mink"	x	
French Marigold	*Tagetes patula* "Naughty Marrietta"	x	x
Pincushion Flower	*Scabiosa atropurpurea*	x	x
Star Phlox	*Phlox drummondii cuspidata*	x	
Strawflower	*Helichrysum bracteatum*	x	
Verbena	*Verbena hortensis*	x	
Forget-Me-Not	*Mysotis sylvatica*	x	
Perennials			
Devilsbit scabious	*Succisa pratensis* "Dwarf Form"	x	
Gayfeathers (purple)	*Liatris spicata*		x
Globe Thistle	*Echinops ritro*	x	
Michaelmas Daisy	*Aster novae-belgil* varieties	x	
Fall Phlox	*Phlox paniculata*		x
Pincushion Flower	*Scabiosa caucasica* "House Hybrids"	x	
Dwarf Pincushion Flower	*S. lucida*	x	
Sea Holly	*Eryngium planum*	x	
Showy Sedum	*Sedum spectabile*	x	x
Stonecrop	*S. spurium*	x	
Sheperd's-Scabious	*Jasione perennis*	x	
Blue Monkshood	*Aconitum napellus*	x	
Meadowsweet	*Filipendula purpurea*	x	
Garden Chives	*Allium schoenoprasum*	x	
Biennial			
Sweet William	*Dianthus barbatus*	x	
Siberian Wallflower	*Cheiranthus allioni*	x	
Shrubs			
Butterfly Bush	*Buddleia davidii*	x	x
Native or Naturalised			
Labrador Tea	*Ledum groenlandicum*	x	
Dandelion	*Taraxacum officinale*	x	
Red Clover	*Trifolium pratense*	x	x
Wild White Clover	*T. repens*	x	
Lance-leaved Goldenrod	*Solidago graminifolia*	x	x
Black Knapweed	*Centaurea nigra*	x	x
Common Yarrow	*Achillea millefolium*	x	x
Canada Thistle	*Cirsium arvense*	x	
Hawkweed	*Hieracium* sp.	x	

Table 2. Nectar sources used by *Vanessa cardui* and *Vanessa virginiensis* in the Memorial University Botanical Garden during the period 1972-1983.

suggested that this butterfly arrived in our area too late to facilitate reproduction. However, on 2 August 1986, John Eberlie found three larvae feeding on Pearly Everlasting (*Anaphalis margaritacea*) about twenty miles west of St. John's. One week later I accompanied him to the site and collected the two remaining caterpillars for rearing. The caterpillars were in different stages of growth, suggesting the original eggs had been oviposited a few days apart or by different females. Until this single record the closest to Newfoundland this butterfly has been known to breed is on the French Islands of St. Pierre and Miquelon off our south coast. On this occasion larvae were found feeding on Dusty Miller (*Artemisia stellariana* Besser), a plant not to be found in Newfoundland except as an ornamental in a few city gardens. The genus *Artemisia* is not usually utilized as much for egg laying by this butterfly as are those of the *Anaphalis*. *A. marginitacea* is common in many parts of Canada, including Newfoundland, and is known as an important host for *V. virginiensis* in the Ottawa District of Ontario (Layberry *et al.*, 1982).

Both species of Painted Lady are habitual flower visitors. *V. cardui* appears more catholic in its tastes than does *V. virginiensis*. Of the many nectar sources grown in the Garden especially for pollinating insects, *V. cardui* has been observed nectaring from 34 types, while *V. virginiensis* from only 11 (see Table 2). Even though most of these plants are in flower while *V. virginiensis* is in the Garden, this species appears to show a preference for nectaring from native or naturalized plants rather than from the wider variety of exotic blooms available to it. This opinion was formed by watching the behaviour of certain individuals of both species with special attention paid to their reaction to native or naturalized flora growing adjacent to exotic material. However, only the species of flowers visited by the butterflies were actually recorded. No serious effort was made to count the number of visitations to each flower or to time the period spent nectaring at each source by the individual butterflies.

Though both Painted Ladies are aggressive butterflies, they can often be seen feeding companionably with other nymphalids. Nevertheless, I have seen a small specimen of *V. virginiensis* continuously harassing Red Admirals (*Vanessa atalanta*) and Mourning Cloaks (*Nymphalis antiopa*) larger than itself. *V. cardui* often chase Red Admirals in the Garden and I have twice seen one vigorously attack and chase a large dragonfly (*Aeshna* sp.) off one of our flower beds.

As with most butterflies, *V. cardui* has a number of natural controls. In the study area I have seen its larvae with the typical symptoms of virus attack, and others that had hosted the larva of a parasitic fly. In the latter case the usual sign is the sight of the fully grown caterpillar in a deflated condition, with a droplet of moisture at the site where the fly maggot emerged. As is to be expected our caterpillars are also parasitized by parasitic wasps, a single egg being placed in the body just prior to pupation. This typically results in an adult wasp emerging from the chrysalis instead of the expected butterfly imago. Caterpillars collected in the wild for hand rearing are often infested this way.

Painted Ladies are preyed upon by birds and large dragonflies in the Garden but not all attacks are successful. In 1981, a freshly emerged imago of *V. cardui*, on being attacked in flight by an *Aeshna* dragonfly, simply zigzagged at high speed for a few feet and then dropped like a stone to the ground, remaining still for a full minute (I have seen the Pink-edged Sulphur, *Colias interior*, do this also). It then fluttered up onto a flower, opened its wings and commenced to "sun". When an *Aeshna* next cruised by, the butterfly immediately flicked its wings closed and remained still.

Both these butterflies inhabit the open, well lit areas of the Garden. They are more often to be found around the flowerbeds, grassy areas, the larger sunlit woodland glades and along the wider trails. Both spend much time sunning on bare or sparsely vegetated earth and on gravelled surfaces, areas that attract and retain the sun's warmth. Though Clench (*in* Howe, 1975), suggests that *V. virginiensis* perhaps ranges a little more into forest edges than does *V. cardui*, I have not as yet recorded any difference in their foraging areas within the botanical garden. Indeed, in the Garden, I cannot recall ever observing either species among the trees of our wooded areas except in the recently (1961) burnt-over forest, now regenerating to deciduous scrub.

Acknowledgements

I would like to thank David Larson (Biology Department, Memorial University of Newfoundland), and Ray F. Morris & Kenneth Proudfoot (Agriculture Canada, St. John's, Newfoundland) for reviewing and making suggestions on the original manuscript.

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Updates to the Biology and Distribution of *Philotiella speciosa* (Lepidoptera: Lycaenidae)

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Abstract

Details of the behavior, larval hostplants, and distribution of *Philotiella speciosa speciosa* (Hy. Edwards) and *P. s. bohartorum* (Tilden) are presented. The former is seldom collected and the latter is known from only a few specimens. Rainfall patterns play a major role in determining their emergence on any given year. Baja California Norte, extreme western Arizona, and two Nevada counties (Lyon and Mineral) are significant range extensions.

This note is an update to Shields (1974) on the biology and distribution of *Philotiella speciosa.* Mattoni (1977) has since recognized that *speciosa* is morphologically distinct from *Euphilotes* and erected the new genus *Philotiella* for it. A comprehensive revision of *Oxytheca*, a host of *P. speciosa*, has recently appeared that includes much distributional data (Ertter, 1980).

Information is now available for the large colony at the northwestern base of Red Mountain, San Bernardino Co., California. *P. speciosa speciosa* (Fig. 1) flies there in April and early May on wet years such as 1974 and 1976. On calm days males patrol the gullies while females fly close to the ground over small hillsides where *Oxytheca perfoliata* T. & G. (Fig. 2) grows in semi-dense mats, from 0830-1700 h (PST). The peak flight was 0930-1330 h (PST). One copulating pair was observed at 1400 h (PST). Males defend territories, chasing other males and Diptera. Females usually oviposit singly on either side of the first and largest bract of *Oxytheca* after much hovering. The two primary nectar sources were *Eriophyllum wallacei* (Gray) Gray and *Chaenactis fremontii* Gray.

Requirements for good seed germination and growth of another larval foodplant *Eriogonum reniforme* Torr. & Frem. are not frequently met. *P. speciosa* emergence may be tied to these same conditions since they only fly when the foodplant is in bloom. Timing and duration of late fall/early winter rains may be critical for its emergence. During most years even the main colonies are unproductive, especially during drought years. Devastating flash floods in the late summer of 1976 apparently ripped out the main colonies in Devil's and In Ko Pah Gorges; over 30 larvae were collected on *E. reniforme* flowers there in 1985 some 9 years later, presumably repopulating from unflooded side canyons. Except for primary colonies (e.g. Red Mtn., ca. 32-48 km NE Mojave on the old dirt road to Randsburg, Kramer Hills, and Devil's and In Ko Pah Gorges prior to 1976), *P. speciosa* is found unexpectedly and in small numbers, making it a particularly difficult insect to locate. At 80 km S. of Catavina, Baja California Norte, Brown and Faulkner (1984) found *Chorizanthe pulcella* Brandegee and/or *Eriogonum thurberi* Torrey as potential foodplants by adult association. *E. thurberi* is a close relative of *E. reniforme* and occurs in Baja California Norte, southern California, and much of western and southern Arizona, blooming in March to July. *E. reniforme* is not known from Baja California.

P. speciosa bohartorum Tilden (1967) has not been collected since 1970 at Briceburg, Mariposa Co., California, despite numerous attempts by various collectors. On 23-24 April 1966 (incorrect dates given in the original description), J. Lane and K. Hughes collected 4 males and 1 female at 5 different locations along the north side of the Merced River at Briceburg, mostly between the bridge and the old railroad trestle ca. 0.5 km W. The males were coming to moisture (especially wet sand) at the river's edge and a small side creek, in mid-morning. The only female observed was resting on a dry stem at the base of some rocks of the side creek at ca. 1000 h PST (possibly roosted there from the previous night), adjacent to a bank of *Chorizanthe membranacea* Benth., the probable foodplant. The Merced River was unusually high that year. J. Mori collected 1 fresh male on 11 April 1970, ca. 1.2 km E. Briceburg, flying along the old railroad bed at 1315 h (PST). Late April seems to be the peak flight but only during exceptional years. On 14 April 1974, I saw but missed a *speciosa* (possibly *bohartorum*?) in the large canyon W. below Chili Bar, 6.5 km N. Placerville, El Dorado Co., California, at 1145 h (PST). *Chorizanthe membranacea* occurs on dry rocky slopes below 1370 m, in the Inner Coast Ranges from Mendocino and Siskiyou Cos. to Ventura Co., and the Sierran foothills from Butte & Tuolumne Cos. to Kern Co., California, flowering from April-July.

The *P. s. bohartorum* record from Hume Lake road, 1830 m, Fresno Co., California (Garth & Tilden, 1986) needs to be verified. G. S. Garth has stated (*in litt.*, 6 May 1986): 'It is a worn female and had obviously flown or been wind-borne from some lower level (in Kings River Canyon). I marked the 1830 m contour where it intersects with the Hume Lake road as the most probable collecting site although memory fades after 60 plus years (it was collected in 1925). At the time I recognized it as differing from the *P. speciosa* that I knew from the Mojave Desert near Randsburg. When *bohartorum* was

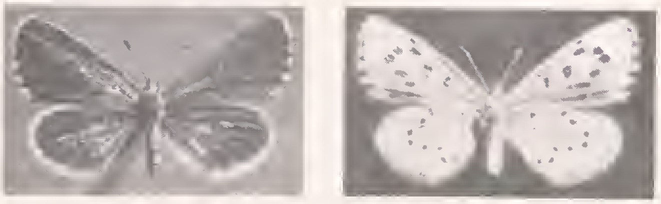

Figure 1. *Philotiella speciosa* female, upper (L) and under (R) surfaces; Red Mountain, San Bernardino Co., California.

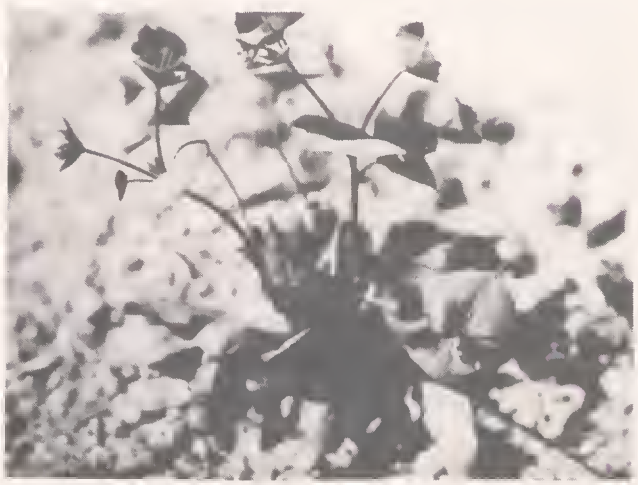

Figure 2. *Oxytheca perfoliata*, same locality data as Fig. 1.

described I assumed that was it, but have never collected topotypical *bohartorum* for comparison. It could be intermediate, considering that the Hume Lake region is both more southerly than Briceburg and also more desertified."

New distribution records for *P. speciosa speciosa* since Shields (1974) include: BAJA CALIFORNIA NORTE: 80 km S. Catavina, 5 & 7 Apr. 1982, 7m 5f (J. Brown & D. Faulkner). ARIZONA: *Mohave Co.*; 4.7 km S. jct. highways 95 & 68, wash just E. Bullhead City airport, 183 m, 4 Apr. 1978 (K. Roever); *Yuma Co.*: Lopez Wash, 14.5 km SE Cibola, 168 m (K. Roever). CALIFORNIA: *Inyo Co.*; Emigrant Canyon, Death Valley Nat'l Mon., 5 May 1976, 2m 1f (R. Wells); Emigrant Springs, Death Valley Nat'l Mon., 1220 m, 26 May 1980, 3m (R.M. Brown); Grapevine Canyon, Park Boundary, Death Valley Nat'l Mon., 1220 m, 27 May 1980 (R.M. Brown); W. slope Last Chance Range, 1770 m, late May 1974, 1f (J.F. Emmel); Lead Canyon, Inyo Mts., 5 May 1982, 1f (J.F. Emmel); Mahogany Flats, Panamint Range, 1830 m, 9 May 1969 (D.L. Bauer); Nemo Crest, upper slopes, Death Valley Nat'l Mon., 1690 m, 26 May 1978, 3m 3f (R.M. Brown); large wash 1.6 km WSW White Top Mtn. peak, Cottonwood Mts., 1890-1950 m, 3 June 1980, 3m 3f (J.F. Emmel & O. Shields); *Kern Co.*; E. end Piute Mts. near Sageland, Kelso Valley 22 April 1984. 1m (J.G. Pasko); *Los Angeles Co.*; Pallette Creek below Valyermo, 30 Apr. 1980, 1m (J.M. Snider); *Tulare Co.*; above Brush Creek, 6.9 km from Johnsondale-Kernville Rd. on Cherry Hill Rd., 14 June 1977, 1f (J. Brock); NEVADA: *Clark Co.*; Willow Spring, Spring Mts., 17 June 1978, 1m (D. Mullins); *Esmeralda Co.*: 17.2 km S. Silverpeak, Silverpeak Mts., 4 May 1981, 5m 2f (G.T. Austin); *Lincoln Co.*; near Hiko Junction, 22 April 1986 (G.T. Austin); *Lyon Co.*; Ft. Churchill Rd., 19.8 km S. U.S. 50, 2 May 1980, 4m 4f, 3 May 1980, 1m 1f, 28 Apr. 1981 (G.T. Austin); *Mineral Co.*; Mariette Rd., 0.3 km N. Nev. 360, 6 May 1981, 1m (G.T. Austin); *Nye Co.*; Peavine Creek Campground, S. end Toiyabe Range, 5 May 1980, 1m (C.S. Lawson); Phinny Canyon Rd., 18-24 km W. U.S. 95, Grapevine Mts., 7 & 26 May 1983, 2m + 4 (G.T. Austin).

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Abstracts of Papers Presented at the 14th Annual Meeting of the Xerces Society Gainesville, Florida USA 9-14 June 1987

Ecological factors critical to cold hardiness of monarch butterflies overwintering in Mexico. *James Anderson, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

Overwintering monarch butterflies in Mexico are occasionally subjected to severe winter storms. Experiments to determine monarch cold-hardiness have revealed a moderate supercooling ability. However, two ecological factors strongly influence this capacity to resist freezing: wetting and exposure to the night sky. If monarchs are wet, supercooling ability is thwarted and the freezing of individual butterflies is probable at much higher sub-zero temperatures. If monarchs are exposed to the night sky, radiational cooling results in body temperatures below both the temperature of ambient air and other butterflies less exposed, thus increasing the probability of freezing. Both wetting and exposure are related to the amount of forest canopy overhead and to the position of monarchs within the clusters. An interaction of these factors is particularly critical to survivorship during the hazardous winter storms at the overwintering sites, and must be carefully considered in any rational strategy for the conservation of the monarch migratory phenomenon.

The importance of Lepidoptera research in management plans of Wyoming wilderness areas. *Karolis Bagdonas, Department of Zoology and Physiology, University of Wyoming, Casper, WY 82601 USA.*

Since 1985, Bagdonas' Flying Circus (the BFC) has been collecting baseline ecological data on invertebrates, vertebrates, and plants in several poorly known wilderness areas of the Greater Yellowstone Ecosystem in northwestern Wyoming. This work, under the auspices of the National Audubon Society's Wilderness Research Backpack Program, has become increasingly important to the long range management plans and acid rain research of the US Forest Service and Wyoming Department of Game and Fish. In particular, lepidoptera have become increasingly accepted as sensitive biological indicators by governmental agencies. New state, county, and colony records have also seen increased use in long range management plans of Wyoming Wildernesses and surrounding areas.

The historic overview and the current status evaluation of *Eumaeus atala* (Lycaenidae) in Florida. *Howard D. Baggett, 14406 N. 22nd Street, No. 169, Tampa, FL 33613 USA.*

An historical accounting of the presence of *Eumaeus atala* in Florida via summation of literature is given, and a comparison of recent events and conservation efforts is presented. A discussion of Rober's type description of the subspecies *florida* and of the Comstock & Huntington description of *grayi* is compared, and the current subspecific placement of the Florida population is questioned. The ecological requirements for the butterfly are elucidated: life history, host plants, habitat, and predation. The presentation is concluded with a current status evaluation.

Butterfly world. *Ronald Boender, 3431 N.E. 17 Terrace, Ft. Lauderdale, FL 33334 USA.*

Butterfly displays in America Theme Park, Ft. Lauderdale are discussed. Butterflies already in captivity along with plans of the theme park are reviewed on video.

Status of conservation of monarch butterflies in Mexico. *Lincoln P. Brower, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

This paper presents the realities and ideals of monarch conservation, and suggests what needs to be done to protect the Fir Forests in Mexico where monarchs spend the winter each year. If these measures are not implemented, the eastern population of the monarch in North America will probably become extinct within less than 20 years.

The historical and current status and distribution of the Florida Banded Tree Snail, *Liguus fasciatus*, in southern Florida and the Keys. *Tony Cotter, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

The Florida Banded Tree Snail, *Liguus fasciatus*, was first reported by Thomas Say in 1825. Little was known about the tree snail until the construction of the Overseas Railroad extending from Miami to Key West from 1904 to 1912, and the completion of the Tamiami Trail in 1928, provided access to unexplored regions of the Everglades and the Florida Keys. During the first part of this century, *Liguus fasciatus* ranged from Key West north to Boynton Beach, Palm Beach County, and west to Marco Island, Collier County. Since the discovery of *Liguus* in Florida, destruction of habitat, overcollecting, and translocation of many, if not all of the 58 forms, has obliterated the original distribution and diminished the current status and distribution of the *Liguus fasciatus* in South Florida and the Keys.

Rare and threatened dragonflies (Anisoptera) in Florida. *Sidney W. Dunkle, Entomology and Nematology Department, University of Florida, Gainesville, FL 32611 USA.*

The taxonomic status, ecology, and distribution of the rarer species of Florida Anisoptera are discussed.

The Day Butterfly Center. *Frank C. Elia, Day Butterfly Center, Callaway Gardens, Pine Mountain, GA 31822 USA.*

In the spring of 1988, Callaway Gardens will open the Day Butterfly Center to the public. The Day Butterfly Center will feature an indoor tropical butterfly display and an outdoor native butterfly garden. The tropical garden will stress the importance of habitat conservation. The native butterfly garden will emphasize habitat enhancement. The educational and research potential of the display will be discussed.

Pesticide effects on the survival of the Giant and Schaus Swallowtails. *Peter Eliazar and Thomas C. Emmel, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

In order to assess the potential effect of aerial and truck pesticide spraying for mosquitoes on the endangered Schaus Swallowtail butterfly (*Papilio aristodemus ponceanus* Schaus) on northern Key Largo, a series of experiments was performed with the Giant Swallowtail butterfly (*Papilio cresphontes*), a close congener species which is found in the same habitats, to find the actual level of toxicity (LD 50) of Dibrom (Naled) and Baytex pesticides. Additional experimentation is being carried out to determine the exact LD 50, but to date, we have found that only when Dibrom is diluted to less than 0.01% V/V and Baytex is diluted to less than 0.5% V/V do an appreciable number of third instar larvae survive contact with a non-microliter droplet. Toxicity in later larval stages is slightly less, probably due to greater body mass in the fourth and fifth instars. The Monroe County Mosquito Control Board sprays a 4% V/V concentration of Dibrom in its aerial spray program, and the District uses a 93% Liquid Concentrate of Baytex in its ULV (ultra low volume) truck spray program. All adult *cresphontes* swallowtails die when exposed to a one microliter droplet of these concentrations. Therefore, an important factor in the decline of this endangered species may have been isolated.

The question of protecting endangered species: a case history in the St. Augustine hairstreak, *Mitoura sweadneri. Thomas C. Emmel, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

Considered very local and usually rather rare, the Saint Augustine Hairstreak (*Mitoura sweadneri*) was named by Frank Chermock as a distinct species in 1944, with the type locality as St. Augustine, on the coast of northeastern Florida. It formerly occurred from near the Georgia border south to New Smyrna Beach on the east coast, but is currently facing greatly reduced available habitat due to land clearing for housing and commercial developments there. Working with local conservation groups in St. Augustine and St. Johns County, a remarkable level of cooperation has been reached with local government bodies and developers to protect the butterfly and its only known native foodplant, Southern Red Cedar (*Juniperus silicicola*). A general review of this butterfly and the story of the drive to ensure its preservation will be related as a possible example which would be applicable in other situations in the United States.

The accelerated destruction of the habitat of ***Papilio homerus*** **in Jamaica.** *Eric Garraway, University of West Indies, Kingston, Jamaica, WEST INDIES.*

An illustrated discussion demonstrating the destruction of the habitat and pine forestry planned by the government. The consequences of this on the population of *Papilio homerus* is examined.

Rarity and extinction in butterflies. *Dale W. Jenkins, Allyn Museum of Entomology, 3621 Bayshore Drive, Sarasota FL 33580 USA.*

Extinction, extirpation and rarity are compared between butterflies and other organisms. Rarity includes *false rarity* due to non-valid or confused taxonomy based on intergrades, polymorphism and polyphenism. It is also the result of difficulties in collecting due to inaccessibility, rare and restricted flight, and diapause. *True rarity* results from the interaction of a complex set of historic, edaphic, climatic and biological, including genetic and biotic factors, which are discussed. The effects of twenty kinds of human intervention on butterfly populations and habitats are discussed.

Insect interactions with the composite, ***Verbesina virginica*** **L.** *David W. Johnson, Department of Entomology, University of Florida, Gainesville, FL 32611 USA.*

Indeterminate galls on the stems, inflorescences, and leaf nodes are formed on the composite *Verbesina virginica* L. in south Florida in the winter. Simple traps were used to capture the insects emerging from these galls, and in this way *Asphondylia* sp. (Cecidomyiidae: Dip), *Rileya* sp. (Eurytomidae; Hym), and *Torymus* spp. (Torymidae: Hym) were collected. A wide variety of insects, including Lepidoptera, Diptera, and Hymenoptera, visited the flowers, indicating that this herbaceous perennial is an important nectar and/or pollen source. Interactions between insects and *Verbesina* indicate that a greater understanding of the ecology of local invertebrate communities is needed to insure their conservation.

The effects of forest fragmentation on copro- and necrophagous beetles in the Amazon. *Bert Klein, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

Surveys of dung and carrion beetles in clear cut, contiguous undisturbed forest and 1 and 10 ha forest fragments indicate a significant decrease in species richness of the guild in small forest fragments and clearcut areas. No significant difference in equitability or total number of individuals (all species combined) was detected. The larger species of beetles were captured significantly less in 1 and 10 ha forest fragments than in contiguous undisturbed forest. These differences may influence rates of decomposition and nutrient cycling in forest fragments.

Costs and benefits of milkweed cultivation for monarch butterfly conservation. *Stephen B. Malcolm, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

It is intuitively appealing to enhance an organism's environment to encourage greater numbers and longer visits. Historically these enhancements have been aimed at birds and mammals. Recently however, butterfly gardening has become popular; wild plants are grown to provide both larval and adult food for almost any non-pest lepidoptera. Inevitably monarch butterflies intrigue butterfly gardeners since they are conspicuously attractive and have a very well publicized and spectacular life history. This paper discusses three tactics of milkweed cultivation, in relation to monarch breeding and migration: 1) Cultivating any milkweed species anywhere, 2) Cultivating any of the local milkweed species, 3) Cultivating only the most abundant local milkweed species. Tactic 1 is considered irresponsible and counterproductive. Tactics 2 and 3 are considered in the light of current ideas of how plants and insect herbivores interact and since monarchs do not feed on 80% of milkweed species, tactic 2 is likely to be unproductive. Thus, for sound ecological reasons tactic 3 is considered the most productive and environmentally sound method.

Comparative biology and distributional status of Megathymidae in Florida. *Deborah Matthews, Allyn Museum of Entomology, 3621 Bayshore Drive, Sarasota, FL 33580 USA.*

The family Megathymidae is represented in Florida by two species, *Megathymus yuccae* (Boisduval & LeConte) and *M. cofaqui* (Strecker). The larvae of this genus are borers, feeding in the roots and rhizomes of *Yucca*. Though exhibiting similar life styles, the two species are ecologically distinct both temporally and with respect to microhabitat preferences. Two species of *Yucca* are utilized in Florida: an endemic, *Yucca flaccida*, and a naturalized species, *Yucca aloifolia*. In North and Central Florida, the coastal plain and sandhill ridges support adequate stands of *Y. flaccida* for both species of *Megathymus*. In South Florida, *Y. flaccida* is restricted to isolated fossil dunes lacking populations of *Megathymus*. Coastal populations of *Megathymus*, particularly those of the barrier islands, depend on *Y. aloifolia*. *Yucca* of these habitats are often under considerable stress due to several physical and biological factors. Once extensive along the west coast stand, *M. cofaqui* is presently restricted to only a few of these barrier islands.

The distribution and ecology of *Papaipema sulphurata* on Cape Cod and adjacent areas in Massachusetts. *Mark J. Mello, Lloyd Center for Environmental Studies, 430 Potomska Road, South Dartmouth, MA 02748 USA.*

The present distribution of a moth apparently endemic to Massachusetts, *Papaipema sulphurata*, listed as threatened by the Mass. Natural Heritage Program was updated by surveying 28 Cape Cod wetlands and 12 off-Cape wetlands containing the larval foodplant, water-willow (*Decodon verticillatus*) from July 20 to November 14, 1986. The presence of 93 larvae, pupae or exuviae of *P. sulphurata* were detected in the stems of water-willow from wetlands in Provincetown, Wellfleet, Orleans, Brewster, Harwich, Yarmouth, Barnstable, Sandwich and Falmouth on Cape Cod; and also in Wareham, Naushon and Cuttyhunk. The number of *P. sulphurata* found per wetland ranged from 1 to 36; the latter population occurring in a vernal pond in Barnstable; the only wetland surveyed where more than 7 individuals were found. The total number of adults produced on Cape Cod during fall, 1986 was estimated to be 2045 (error of estimation: 849-3241) based on number found (78), percent of water-willow checked, percent of wetlands containing water-willow surveyed and estimated number of wetlands containing water-willow on Cape Cod. Water-willow located in seasonally flooded wetlands such as vernal ponds or along the upland edge of permanent water bodies contained virtually all the *P. sulphurata* encountered. The mean height of the exit hole which is located at or near the top of the stem burrow was 25 cm above the base of the plant, the mean width of the stem at the exit hole was 8 mm, and the mean length of the burrow was 13 cm. Changes in water level could potentially have an effect on the survivorship of this species. Although the State Wetlands Act (Ch. 131, s. 40) has jurisdiction over alterations to wetlands relative to human activity, the critical habitat for *P. sulphurata*, the upland edge or seasonally flooded wetlands such as vernal ponds, might not be adequately protected under this statute. Low numbers of individuals found in any given wetland suggest that clusters of wetlands containing suitable habitat are necessary for long-term survival of *P. sulphurata*. To insure the continued survival of this species, conservation of these habitats should be addressed in wildlife management.

The transformation of Brazilian natural areas and the survival of butterflies. *Olaf H. H. Mielke, Dept. Zool., S. Cienc. Biol., Universidade Federal Do Parana, Caixa Postal 3034, 80.000 Curitiba, Parana, BRAZIL.*

A general review of the conservation of natural areas in Brazil, along with the native butterfly fauna, will be presented, including Brazilian laws for the protection of animal life, national parks, biological reserves, and the status of rare and endangered Lepidoptera. The rapid rate of clearing of the Brazilian forests will be a topic of special emphasis.

Note on the status of Bahamian butterflies with specific reference to *Heraclides aristodemus* (Papilionidae). *Lee D. Miller, Allyn Museum of Entomology, 3621 Bay Shore Road, Sarasota, FL 33580 USA.*

With the exception of Grand Bahama and New Providence, the Bahamas remain relatively undeveloped. There is little or no agriculture, and lumbering has been kept to a minimum. Additional conservation measures that provide protection for the Bahamian butterfly fauna relate to the necessity of obtaining collecting permits. This requirement is enforced by local police, assisted by agents of the Bahamas National Trust. The latter organization is very active in matters dealing with the conservation of natural treasures, and one lepidopteran species that is of special concern is *Heraclides aristodemus.* There are now three subspecies of this insect in the Bahamas, and none are presently in danger of extirpation.

The population biology of the Schaus Swallowtail *(Papilio aristodemus ponceanus)* in the Florida keys. *Marc C. Minno, Department of Zoology, University of Florida, Gainesville, FL 32611 USA.*

The Schaus Swallowtail (*Papilio aristodemus ponceanus*) formerly occurred in the tropical hardwood hammocks surrounding Biscayne Bay and throughout the keys of southern Florida. Today, this butterfly is found only in the Upper Keys in localized areas where the hardwood hammocks still remain. Adult Schaus Swallowtail abundance in Biscayne National Park varies from few to many hundreds each year. This variation partly reflects environmental conditions as pupae may diapause for more than one year and eclosion is influenced by rainfall and other factors. In contrast, less than twenty adults have been seen since 1984 outside of Biscayne National Park in hammocks where they once occurred by the hundreds as recently as the early 1970's. Biological observations and mark-recapture studies indicate that the Schaus Swallowtail has specialized requirements which have rendered this Federally Endangered species vulnerable to subtle as well as gross habitat alternations.

Factors affecting the abundance of *Asphondylia boerhaaviae* (Cecidomyiidae) throughout its geographic range. *John Parnell, 205 Meadowcross Drive, Safety Harbor, FL 34695 USA.*

Asphondylia boerhaaviae can be studied by examination of pupal cases and pupal chambers on its obligatory hostplant *Boerhaavia.* Details of past successful emergence, or loss of specimens due to disease and parasitism can be obtained from material collected in the field. The survival rate of two populations (Central Florida and Jamaica) show that parasitism plays a major role in limiting numbers in Jamaica where the insect is abundant (survival rate approx. 34%) but that parasitism is absent in Central Florida where the hostplant is near the northern margin of its range. Adult populations are 15 times smaller than in Jamaica but survival rate is approximately 89%.

The Rosemary Wolf Spider: a Florida species with a highly restricted distribution. *Jonathan Reiskind, Zoology Department, University of Florida, Gainesville, FL 32611 USA.*

An overview of the Overview of ranges of wolf spiders in Florida is presented, along with notes on the habitat requirements and distribution of the rosemary wolf spider. Discussion of loss of habitat due to development is also presented. The U.F. Preserve protects parts of the habitat forever.

The role of The Nature Conservancy and Natural Heritage Programs in setting conservation priorities for invertebrates. *Dale F. Schweitzer, The Nature Conservancy, 294 Washington Street, Suite 740, Boston, MA 02108 USA.*

The Nature Conservancy has a narrowly defined mission: the preservation of biological diversity. The first step toward accomplishing such a goal must be identification of those "elements" or diversity that are most imperiled. In order to systematically obtain and store data on such "elements", i.e. special plants, animals and rare or exemplary natural communities, TNC has established Natural Heritage Programs by cooperative agreements with the state governments. Such databases are used in conservation planning by TNC, government agencies and others such as private consultants. TNC sets its protection priorities by a dual global and state ranking system based on number of extant occurrences and other considerations. Protection focuses on the most important habitats. In the Northeast, Midwest and increasingly elsewhere, most Heritage Program databases include selected invertebrate groups, e.g. "macro" Lepidoptera, tiger beetles, freshwater bivalves, and cave arthropods. Data from amateur naturalists are important to those inventories. Some Heritage Programs and TNC chapters offer small research grants.

A conservation strategy for *Papilio homerus* in Jamaica. *Tom Turner, P. O. Box 6272, Clearwater, FL 33518 USA.*

The rapid loss of primary forest habitat of *Papilio homerus* is continuing and threatens the survival of the species in the short term. Although a proposal with WWF may be forthcoming to begin basic projects, the situation is reviewed from the standpoint of the end results needed to ensure that the species does not become extinct. Larval foodplants are discussed, and proposals for farming/ranching scientific parks and forestry/fruit farming which would assist the insect are reviewed.

Size dependent physiological response to methoprene, a juvenile hormone analog: a possible proximate explanation for multiple mating strategies in monarch butterflies *(Danaus plexippus)* **L.).** *Tonya Van Hood, Entomology Department, University of Florida, Gainesville, FL 32611 USA.*

Male monarch butterflies show size dependent alternate mating strategies at overwintering sites in Mexico. Only small males mate before remigrating. Breaking of reproductive diapause is associated with gonad development resulting from increasing titers of juvenile hormone (JH). To test for size dependent differences in gonad development at particular JH levels, I injected male monarchs with low and high doses of methoprene, a JH analog. Males respond to exogenous methoprene with increased tubular gland (TG) weight relative to body weight. This is the first time methoprene has been shown to mimic naturally occurring JH in an adult lepidopteran. TG response appears dose dependent, with larger doses resulting in heavier mean relative weights. Mean relative TG weights were significantly heavier in small than large males only in the low dose treatment. Greater reproductive gland growth at low JH titers provides a proximate mechanism leading small but not large males to break reproductive diapause and begin mating before leaving Mexican overwintering sites.

Reef corals and coral reefs: biology and threats from coastal development. *George F. Warner, Biology Department, George Mason University, 4400 University Drive, Fairfax, VA 22030 USA.*

Coral and sea anemone-like coelenterates with calcium carbonate skeletons. Reef-building corals contain symbiotic algae which contribute by photosynthesis to the nutrition of the corals. Coral reefs are best developed in clear, nutrient-poor (oligotrophic) waters where they maintain a paradoxically high productivity by tight and rapid recycling of nutrients. However, unlike estuaries, coral reefs do not export much production and are easily overfished. The major threats to coral reefs come from coastal developments such as forest clearance and agriculture which lead to runoff of turbid water with increased nutrient concentration. These changes favor the growth of fleshy algae which overgrow the corals, and increase sedimentation which drains energy from corals' self-cleansing mechanisms. Increases in generalized point and non-point urban pollution further threats arise from tourism and from commercial collection of reef biota such as shells and fish.

The biology and exploitation of Black Corals.. *George F. Warner, Biology Department, George Mason University, 4400 University Drive, Fairfax, VA 22030 USA.*

Black corals are colonial coelenterates belonging to the order Antipatharia. The skeleton is composed of a black, horny material, flexible in life. Colonies are tree-like, often fan-shaped, and may take up to 50 years to grow to a large size of about four feet high. Black corals are passive, predatory suspension feeders, feeding on zooplankton. They prefer current-swept environments in water deep enough to avoid competition from photosynthetic organisms. Black coral jewelry consists of polished pieces of skeleton. Commercially harvested black coral species occur on hard substrates off coral reefs at depths of 100-200 feet. Uncontrolled exploitation has led to considerable reduction in stocks worldwide over the last 20 years. Little is known of the biology of black corals and many species and their associated biota remain to be described.

The conservation of threatened British Butterflies: an in-depth study of their biology and ecology as a vital necessity before implementation of conservation measures. *Ken J. Willmott, 34 Day Brook Road, Merton Park, London SW19 3DH, UNITED KINGDOM.*

Out of our 59 resident species of butterflies, one has become extinct in the last decade (the Large Blue *Maculinea arion*), and another has become extinct in its English localities (the Checkered skipper, *Carterocephalus palaemon*), although it is still well established in the northwest of Scotland. The Large Tortoishell butterfly *(Nymphalis polychloros)* is now such a rarity that it is believed not to have a viable breeding colony left. When reported they are thought to be the result of escapes from commercial butterfly farms or amateur breeders. There is also the possibility of the odd migrant Large Tortoishell being recorded. This leaves us with only 56 species in England, 16 of which have suffered a major contraction of their range. In-depth ecological studies of these species are urgently needed. Several of these species have even disappeared from Nature Reserves, some established specifically to protect them. This shows our current lack of knowledge and inability to successfully manipulate such nature reserves to maintain healthy population of the desired species.

Quantifying habitat requirements of monarch butterflies in Australia. *Myron Zalucki, Zoology Department, University of Florida, Gainesville, FL 32611 USA.*

This paper examines the daily movements of male and female monarchs in relation to density of larval hostplants in Australia. Females lay more eggs on small patches and isolated plants, and spend less time in large patches. Males spend more time around large patches waiting for females. Plots were made of all foodplant densities near Brisbane. By plotting the daily movement of individuals, and extrapolating using a computer, it proved possible to generate a model which predicts what the female will do and how many and where the eggs will be laid during its lifetime.

Book Reviews

The Ecology and Conservation of the Purple Emperor Butterfly *(Apatura iris). K. J. Willmott. 1987. Approx. 200 pp. (report prepared for the World Wildlife Fund).*

This privately printed research report describes results of a 3-year field study on the life history and ecology of the Purple Emperor butterfly in England. Findings are used to offer suggestions for management of the butterfly and its habitat. Although Willmott has studied the Purple Emperor for nearly 20 years, this report focuses on studies that were conducted from 1984 through 1986, under the auspices of the World Wildlife Fund and sponsored by Associated Tyre Specialists Ltd.

The velo-bound report consists of the following items: about 60 pages of text, 33 figures, 22 tables, 68 pages containing 111 black and white photographs, and five appendices. A few of the figures and tables are interspersed throughout the main body of text, but most are grouped together before or in the appendices. The main text of Willmott's report is divided into several unnumbered chapters, which can be grouped into three primary sections:

1) The first section discusses the historical and present-day distributions of the Purple Emperor butterfly in England. Even though I inferred that the Purple Emperor's geographic range has declined due to loss or alteration of its habitat, this or other reasons for the butterfly's decline were not explicitly stated. The next chapter is titled Species Ecology, but it primarily describes adult male feeding behavior and daily activity patterns. The third chapter details various physical (temperature, topography, sunlight, etc.) and vegetational (species present, relative abundance, spatial arrangement, etc.) features of four study sites. A brief fourth chapter describes courtship and mating behavior. The next two chapters describe oviposition behavior as well as characteristics (age, girth, height, etc.) of the individual foodplants selected for egglaying by the females.

2) Basic life history information is presented in the second section, including estimated development times for eggs, larvae, and pupa, plus larval foraging behavior.

3) The third section relates information on propagation of the butterfly's *Salix* larval foodplant. describes conservation measures employed at two sites, and discusses other general problems regarding conservation of the Purple Emperor throughout its geographic range.

The five appendices contain written accounts and photographic logs of larvae observed in the field, oviposition site data, written summaries about the butterfly's status at other sites in England, France, and Switzerland, plus detailed maps of the primary study site. Numerous companion figures, tables, and photographs provide a wealth of information about the butterfly's natural history.

Overall, Willmott's report is well done. The following comments are intended merely as suggestions to enhance the report's format and contents. First, all headings to delineate chapters and sections are of the same style and format. Readability would be improved if different lettering or style/formats were used to differentiate chapter headings from section headings in the report. Second, scientific names of animals and plants should be underlined or otherwise differentiated from normal text. Thirdly, some of the supporting data in the tables and figures is only sparingly referred to in the main text. Although some figures, such as those illustrating climatic data, are largely self-explanatory, others, such as the tables itemizing daily mean wind and maximum gusts data for July and October, would benefit from additional explanation to describe their potentially adverse effects on the butterfly.

Finally, despite numerous measurements of many factors, such as egg position on a leaf, leaf height above groundlevel, tree girth, height, and age, etc., virtually no statistical analyses were employed to substantiate some of Willmott's statements and bolster his conclusions. Furthermore, the results of statistical analyses might provide additional insight about factors relevant to the butterfly's conservation. Perhaps these analyses will be undertaken in future reports on the Purple Emperor or papers eventually prepared for publication in scientific journals.

Willmott's research has elucidated several essential features of the Purple Emperor's life history, ecology, and habitat requirements. Results of his studies should provide a practical foundation for implementation of necessary conservation measures. I hope that Willmott will publish his findings in scientific journals to stimulate other entomologists, both professional and amateur, to investigate the natural history of other butterflies in need of conservation action.

Richard A. Arnold, *50 Cleaveland Rd., No. 3 Pleasant Hill, CA 94523 USA*

Butterfly Houses in Britain, the Conservation Implications. *N. M. Collins. 1987. 60 pp., plus 4 appendices (report prepared for the Nature Conservancy Council, UK Department of the Environment, and the World Wildlife Fund).*

Butterfly houses, which are, in effect, butterfly zoos, are a rapidly growing phenomenon in Great Britain. Dr. Collin's report to the IUCN considers the nature of these houses, the manner in which they are maintained, their interface with the viewing public, and their problems and potential with regard to education, conservation, and research. While the report is of great interest in understanding what is going on currently in this field, it should have even greater importance in guiding, and modifying, the development of butterfly houses throughout the world.

A butterfly house must have sufficient (and adequately controlled) light, warmth, and humidity for good plant growth, including species suitable as nectaring sources and even larval host plants for its habitants. It must be continuously stocked with butterflies (and perhaps moths and other insects) selected for visibility, availability, and (as much as possible) longevity. Physical design must be such that butterflies do not become trapped or damaged in peaks and corners; the public should be able to walk within the exhibit and view it easily and safely.

The concept seems simple, but the problems are many. A single enclosure can embrace only a limited temperature and humidity range, so it is usually not feasible to house tropical and temperate species together. While it is possible to maintain larval host plants in palatable condition for some species, for others this proves impractical. The larvae must therefore be reared in specialized quarters, or, as is usually the case, pupae must be shipped in from rearing sites throughout the world. Viral diseases often curtail rearing from midsummer on. Because chemicals can obviously not be used for control of pest insects, biological control methods are employed: an Australian ladybird beetle for scale and mealybugs; a commercially reared wasp to control whiteflies; and a predatory mite for red spider mites. Chinese painted quail are helpful in consuming ants and spiders.

In a recent year 233 species of lepidoptera were flown in the various houses at one time or another, but a single house may be showing only 10-40 species at one time. The average is 25-75 species throughout the year, with the maximum being 70 species at one time and 150 in a season. Danainae, Nymphalinae, and Papilionidae are most commonly used, as well as species of Heliconiinae and Pieridae which breed well in captivity. Lycaenidae, Satyrinae, and Hesperiidae are rarely shown. The species almost universally used include only 21 butterflies, all tropical, and the Atlas and Indian Moon Moths. Nine common British species are commonly shown, usually in special netted enclosures for lower temperature and humidity.

The number of live specimens involved is staggering. An average house of 5000-10000 square feet may fly 500-1000 specimens at one time. While accurate figures were difficult to obtain, Collins estimates the use of about 10000 specimens per establishment in a season, or about 440000 specimens per season (based on 1985 and 1986 figures) for the entire industry of 44 houses.

How are the butterflies obtained? One-third are reared on the premises, 27% are purchased from dealers within the UK (who apparently are middlemen, not breeders), and the remaining 40% directly from overseas dealers. The vast majority are shipped in the pupal stage, with acceptably low mortality if proper procedures are used. Shipment of adults in paper triangle envelopes carries a mortality in the neighborhood of 40% and is usually resorted to when a rapid population boost is needed. Collins properly condemns this as poor practice and symptomatic of poor management.

The economics of the industry is likewise impressive. In one year an estimated 3.67 million viewers (at an average admission price of 1.24 pounds) yielded 4.55 million pounds in gross revenues. On the other side of the coin, pupae purchased from British dealers average about 2.00 pounds apiece.

Dr. Collins gives lengthy treatment of government regulations relating to shipment of live insects into the country, the regulation and inspection of zoos (butterfly houses seem to lie in a bit of a gray area in this regard), and efforts of the industry to form a federation or trade organization. He feels that this latter might best be accomplished within the existing framework of the National Federation of Zoologic Gardens of Great Britain and Northern Ireland. There are also useful appendices on addresses of butterfly houses and of pertinent governmental and conservation agencies, a list of species flown in butterfly houses, and the "free list" of species which can be imported alive without restriction. (Almost none of the "free list" species are flown in butterfly houses. However, the vast majority of species utilized would, in the event of escape, be unable to survive and multiply in the British climate. Curiously, many on the "free list" seem capable of surviving.)

The foregoing has been largely descriptive. The more important part of Collins' report deals with comments and recommendations regarding regulation, the role of butterfly houses in education, and the potential for basic research. The relation to conservation draws particular attention.

An educational role of the butterfly houses is to enable the visitor to see, enjoy, and begin to understand the environmental needs of a butterfly species, and to sense the role of a tropical forest. The contingent expectation is that at least some views will thereby kindle or reinforce an interest in global ecology and conservation. The owners also understand the value of school-oriented efforts, and that children return bringing adults. Collins stresses the need for accuracy of biological information and scientific names, and the use of accepted rather than contrived common names. He also recommends the use of computer-generated handouts describing the species that are being exhibited on a given day.

As to research, while the current investigations of immature morphology and chemical aspects of foodplant relationships are commendable, he feels that research attention should be directed particularly to the welfare of the display insects: optimizing environments, improving breeding potential, use of artificial diets, etc.

With regard to conservation, Collins emphasizes the importance of adherence to the various listings of the IUCN, the European Economic Community, etc., designating "threatened" and "endangered" status. *Eumaeus atala*, "patron saint" of this journal, is flown at times in butterfly houses, using material reared in Florida. This is neither detrimental nor beneficial to its survival in the wild (where it is actually making a comeback). Certain southeast Asian birdwing butterflies flown in the past but now banned by EEC regulation of whole genera (*Troides*, *Trogonoptera*, and *Ornithoptera*) were nonthreatened species readily reared commercially. He recommends that repeatedly updated IUCN listings, and updated information on insect-related legislation worldwide, be made readily available to butterfly houses.

While protection and appropriate management of key habitat are underscored as the *sine qua non* of butterfly conservation, the suggestion is made that *ex situ* rearing of certain selected threatened species in butterfly houses could be of value, (1) for recolonizing patches of recovering habitat from which the species has disappeared, and (2) in acquainting the viewing public with the need for (and raising funds for) specific conservation efforts.

The ties between butterfly houses and *in situ* conservation are at best dubious. The butterfly "farms" and back-yard breeding operations which supply live pupae deal largely in common species and have much in common with the American "broiler factories" supplying the fast-food industry. There is a concept of rearing threatened species, developing an economic market (for pupae for butterfly houses), and hence furthering habitat conservation to maintain a source of breeding stock for that market. This is theoretically reasonable but has yet to be realized. Dr. Collins concludes by noting that the British butterfly house industry – numbering one in 1960, two in 1977, and 44 in 1987 – is still in a growth phase but will probably soon reach maturity (note that 1960 was not the actual beginning: I remember with pleasure visiting the Whipsnade Zoo in 1937 to see a large screened enclosure filled with live British butterflies, as well as many smaller exhibits of exotic moths going through their life cycles).

It is important that the industry prepare to return some of its profits to their source, i.e., butterflies and their well-being and conservation. Furthermore, it must improve its methods of supply, handling, and management of the butterflies, so that the public's feeling for the butterfly house will not turn from fascination to skepticism and even aversion. Public acceptance of vertebrate zoos has been experiencing such a decline.

The butterfly house industry in other developed countries is in the budding stage; for example, a new facility in Florida and another in Georgia in the US in 1987. The problems in each country will vary in detail, but not in general. For instance, escape of exotic species within the United States with its great diversity of climates and habitats, poses problems different from those in Britain. But one need is universal: to look beyond the business aspects of the undertaking to those of education, research, relation to conservation issues, and in particular, the interests of the insects themselves as individuals and as species.

The information and insights provided by Collins in this report can and should provide essential guidance to anyone, from entrepreneur to spectator, with an interest in the development of the butterfly houses over the next decade.

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The Ecology of Tijuana Estuary, California: an Estuarine Profile. *Zedler, J. B. and C. S. Nordby. 1986. US Fish & Wildlife Serv. Biol. Rep. 85 (7.5). 104 pp.*

The Tijuana Estuary is located in the extreme southwestern corner of San Diego County, California. The natural integrity of the estuary is maintained thanks to its designation in 1982 as a National Estuarine Sanctuary. However, its ultimate preservation has international ramifications, since three-fourths of its watershed is in Mexico. Zedler and Nordby, biologists at San Diego State University, point out that the Tijuana Estuary is also unusual among estuaries in its 'diversity of ecological communities, which provide habitat for a variety of rare and endangered species; and its history of ecological study, with extensive data from years with and without catastrohpic disturbances."

Indeed, the estuary is home to at least 15 rare and endangered species, and there are more than 40 titles concerning the Tijuana Estuary cited in this report. Among the many invertebrates treated in detail are several species familiar to insect conservationists, including, for example, the Wandering Skipper *(Panoquina errans)* and several tiger beetles *(Cicindela)*.

The authors suggest that California's estuaries may be differentiated from others in the United States by the degree of variability in the physical environment. During over a decade of study, researchers have been able to follow changes in biotic communities influenced by variations in the physical environment, ranging from extreme flooding to equally extreme drought.

The report is a rather brief summary of extensive collections of data and, as such, is not highly technical. The chapters address topics such as estuary type classification, major factors that have shaped the Tijuana Estuary. ecological communities of the Tijuana Estuary, ecosystem functioning, the role of disturbances in modifying salt marsh community structure and function, and management considerations. The report is an excellent regional reference for ecologists and conservation biologists, and I am confident that it will provide fascinating reading for anyone interested in natural history. The fine illustrations of several natural communities, and numerous individual plants, birds, insects and other animals alone make it well worth owning. Requests for the publication should be addressed to: Information Transfer Specialist, National Coastal Ecosystems Team, US Fish and Wildlife Service, NASA Slidell Computer Complex, 1010 Gause Boulevard, Slidell, LA 70458 USA.

David C. Hawks, *Entomology Museum, University of California, Riverside, CA 92521 USA.*

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INSTRUCTIONS FOR CONTRIBUTORS

Formal scientific articles and notes dealing with any aspect of the ecology and conservation of invertebrates and their habitats are solicited. Articles will generally be longer papers, notes not exceeding 1000 words. Reviews of books dealing with invertebrate conservation or endangered habitats are also invited. Appropriate philosophical papers will also be welcomed.

All manuscripts should be typewritten on white, 8.5 x 11 inch, good quality bond paper, on one side only, double- or triple-spaced throughout, with margins of at least one inch on all sides. Manuscripts produced on dot matrix printers are *unacceptable* unless the printer has been set in near letter quality mode. The original manuscript and 2 copies should be submitted; authors should also retain a copy of manuscripts and figures for later consultation with the Editorial Staff.

Include illustrations and/or black and white glossy photographs as appropriate. Figures should be consecutively numbered in Arabic numerals. Hand-drawn figures should be rendered in black ink on good quality white paper, and may be larger than the final reproduced size. These and artwork will be returned after publication if accompanied by return postage. Figure captions should be typed, double- or triple-spaced on a separate sheet, and the number of the figure lightly pencilled on the back of each drawing or photograph. A map should be included as a figure with all articles dealing in a major way with a specific region or invertebrate habitat. Tables should be numbered consecutively in arabic numerals, and submitted on separate sheets in *camera-ready condition*. Cover art/photos change with each issue, and contributions will be gratefully received. Cover material should generally show invertebrates in natural settings, and prospective cover artists should consult with the Editor prior to submitting material.

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The Regal Fritillary, *Speyeria idalia*, a magnificent butterfly whose range in eastern North America has diminished precipitously during the past several decades. In the northeastern USA, the butterfly is now largely confined to a few offshore islands along the southern New England coast. Pen and ink drawing by Lynne Cherry.